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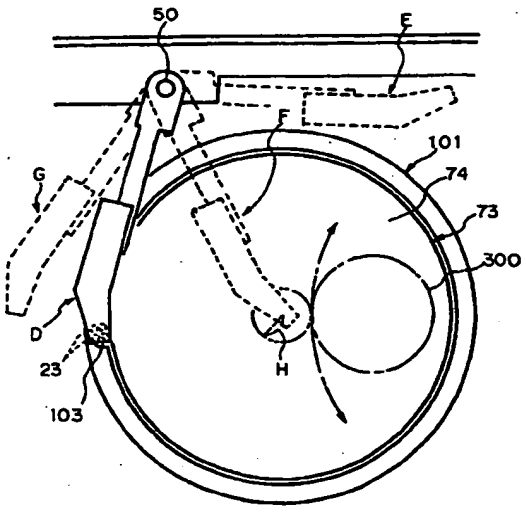
(54) POLISHING DEVICE

(57) This invention relates to a polishing machine for polishing an article such as a semiconductor wafer. The movable arm is located at a liquid supply position for supplying a liquid such as a polishing liquid onto a polishing surface of a turntable. The arm is also adapted to be moved to and held at a retracted position radially outside the polishing surface. At the liquid supply position, liquid supply nozzles supported on the arm are brought into a condition that the nozzles are close to a position on the polishing surface where the liquid is to be supplied whereby the liquid is accurately supplied onto the position. Holding the arm at the retracted position makes it easy to conduct a maintenance work for the polishing surface and so on.

Fig. 5



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D s ription

TECHNICAL FIELD

[0001] The present invention relates to a polishing machine comprising a turntable having a polishing surface for polishing a semiconductor wafer or the like, and a polishing liquid supply unit for supplying a polishing liquid onto the polishing surface of the turntable.

BACKGROUND OF THE INVENTION

[0002] In a semiconductor wafer manufacturing process, a polishing machine is used to planarize semiconductor wafer surfaces.

[0003] The polishing machine of this kind comprises a turntable having a polishing surface and adapted to be turned at a predetermined rotating speed, a wafer carrier that holds a semiconductor wafer, rotates at a predetermined rotating speed and presses a surface of the semiconductor wafer against the polishing surface of the turntable onto which a polishing liquid is being supplied so as to polish the surface of the semiconductor wafer, a dressing tool that is brought into contact with the polishing surface of the turntable while supplying a dressing liquid onto the polishing surface of the turntable to dress the polishing surface, and an airtight housing containing the turntable, the wafer carrier and the dressing tool therein.

[0004] As shown in Fig. 1, in a conventional polishing machine, a polishing surface of a turntable 201, which polishing surface is usually formed by attaching a polishing pad 202 to the upper surface of the turntable 201, is supplied with various kinds of liquids including a polishing liquid and a dressing liquid which are needed for performing certain operations such as polishing of semiconductor wafers, dressing of the polishing surface and so on through a nozzle means 203 which is set above the turntable and connected to a liquid supply tube means 205.

[0005] However, this conventional polishing machine has the following problems.

(1) The nozzle means 203 and the liquid supply tube means 205 which are fixedly held above the turntable 201 hinder maintenance work which includes changing the polishing pad 202 attached to the upper surface of the turntable 201 to a new one.

(2) Although it is desired that the liquid discharged from the nozzle 203 falls onto the polishing surface of the turntable 201 at a position suitable for the liquid to be appropriately spread over the polishing surface of the turntable 201 by a centrifugal force, i.e., a position near the center of rotation of the turntable 201, the position on the polishing surface of the turntable 201 where the liquid falls may b different from such a desired position depending on the flow rate and velocity of the discharged liquid.

[0006] The present invention has been made in view of those problems and it is therefore an object of the present invention to provide a polishing machine with a liquid supply system that does not hinder maintenance work such as the exchange of polishing pads and is capable of positively supplying a liquid at an optimum position on a polishing surface of a turntable.

DISCLOSURE OF THE INVENTION

[0007] According to the present invention, a polishing machine is provided with a liquid supply system comprising a movable arm, and a nozzle supported on the movable arm to supply a liquid onto a polishing surface of a turntable.

[0008] The movable arm is movable between a liquid supply position whereby the nozzle is positioned substantially vertically above a portion of the polishing surface onto which the liquid is to be discharged, and at least one retracted position whereby the nozzle is positioned outside the periphery of the turntable. The polishing machine further comprises a holding device for holding the arm at either the liquid supply position or the retracted position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is a schematic side elevation of an arrangement of a turntable and a nozzle in a conventional polishing machine;

Fig. 2 is a schematic plan view of a polishing machine in a preferred embodiment of the present invention;

Fig. 3 is an enlarged plan view of a turntable and an arm with a liquid supply nozzle unit included in the polishing machine of the preferred embodiment;

Fig. 4 is a schematic sectional view taken along a line 4-4 in Fig. 3;

Fig. 5 is a plan view, similar to Fig. 3, showing a plurality of positions where the arm with the nozzle unit is positioned;

Fig. 6 is a partly cutaway plan view of the arm with the nozzle unit;

Fig. 7 is a partly cutaway side elevation of the arm with the nozzle unit;

Fig. 8 is a plan view of an arm with the nozzle unit in accordance with a second embodiment of the present invention;

Fig. 9 is a side elevation of the arm shown in Fig. 8;

Fig. 10 is a side elevation of a movable nozzle included in the nozzle unit of the arm shown in Fig. 9;

Fig. 11 is a sectional vi w taken along a line 11-11 In Fig. 10; and

Fig. 12 is a sectional view taken along a line 12-12 in Fig. 10.

BEST MODE FOR CARRYING OUT THE INVENTION

[0010] The best mode embodiments of the present invention will be described hereinafter with reference to the accompanying drawings.

[0011] Fig. 2 shows a schematic view of an entire construction of a polishing machine 60 in accordance with an embodiment of the present invention. Referring to Fig. 2, the polishing machine 60 has a polishing unit 70 that performs a polishing operation, and a cleaning unit 90 contiguous with the polishing unit 70. The units 70 and 90 are contained in an airtight housing.

[0012] In the polishing unit 70, a turntable 73 is disposed at the center of the polishing unit 70, and a carrier assembly 77 and a dresser assembly 81 are respectively disposed on either side of the turntable 73. The carrier assembly 77 includes a wafer carrier 75 in the shape of a disk and capable of holding a wafer to be polished and of bringing the wafer into contact with a polishing surface of the turntable. The dresser assembly 81 includes a dressing tool 79 in the shape of a disk for dressing the polishing surface of the turntable 73. A workpiece transfer device 83 is disposed near the carrier assembly 77 to transfer a semiconductor wafer from the polishing unit 70 to the cleaning unit 90 and vice versa.

[0013] The polishing machine performs a polishing operation and a dressing operation as described below.

[0014] A semiconductor wafer to be polished is received through a delivery station a of the cleaning unit 90. The semiconductor wafer is carried through the cleaning unit 90 onto the workpiece transfer device 83 of the polishing unit 70.

[0015] The wafer carrier 75 of the carrier assembly 77 is turned from a position shown in Fig. 2 along a path indicated by an arrow A, picks up the wafer from the workpiece transfer device 83 to hold it on its lower surface, rotates about its axis while returning along the path indicated by the arrow A to a position above the turntable 73, and is then lowered to press the wafer against a polishing pad 74 attached to the upper surface of the turntable for the polishing operation. During the polishing operation, a polishing liquid is supplied onto the polishing pad 74 through a liquid supply arm 10.

[0016] After the polishing operation has been completed, the semiconductor wafer is returned to the work transfer device 83 so that the wafer is cleaned and dried by the cleaning unit 90 and, thereafter, taken outside through the delivery station a.

[0017] After the polishing operation has been completed, the dressing tool 79 is pressed against the polishing pad while being rotated about its axis and swung along the path designated by an arrow B over the turn table 73 so as to dress the polishing pad 74. During the dressing operation, a dressing liquid is supplied onto the polishing pad 74 through the liquid supply arm 10 the detail of which is explained hereinafter.

[0018] The polishing machine according to the embodiment is provided with a liquid supply system for supplying a polishing liquid, a dressing liquid and so on which will be described hereinafter. However, prior to describing the liquid supply system, a liquid draining system will briefly be explained as follows.

[0019] Referring to Figs. 3 and 4, the polishing machine according to the embodiment of the present invention is provided with a splash cover 101 to prevent a liquid such as the polishing liquid supplied onto the turn table 73 by the liquid supply system from scattering out of the periphery of the turntable 73 as the turntable 73 is rotated. The splash cover 101 is provided with a notch 103. An annular trough 111 is disposed under the periphery of the turntable 73. The liquid stopped by the splash cover 101 is collected in the annular trough 111 and is drained from the polishing unit 70 through a drain pipe, not shown.

[0020] The liquid supply system will now be described. The liquid supply system includes the liquid supply arm 10. The liquid supply arm 10 has one end portion supported by a pivot shaft 50 on a frame 121. A nozzle assembly 40 comprising four nozzles 23 for selectively discharging a polishing liquid or a dressing liquid is held on the other end portion of the liquid supply arm 10.

[0021] A detent mechanism 15 is provided near the pivot shaft 50 supporting the liquid supply arm 10. The detent mechanism 15 is able to selectively hold the liquid supply arm 10 at a liquid supply position F (the position shown in Fig. 3) for supplying the liquid, a first retracted position D close to the periphery of the turntable 73 or a second retracted position E radially separated from the periphery of the turntable 73.

[0022] The liquid supply arm 10 has a slide mechanism 12 on the upper surface of its forward end portion, the slide mechanism including a slide member 14. The nozzle assembly 40 is fastened to a forward end portion of the slide member 14 with screws or the like. A cover 13 is detachably attached to the nozzle assembly 40 so as to cover the latter. As shown in Fig. 7, the liquid supply arm 10 can be moved vertically by a hydraulic or pneumatic piston-cylinder actuator.

[0023] The detent mechanism 15 comprises an elastic member disposed at a predetermined position on the frame 121, a ball pressed against the lower surface of the base end portion of the liquid supply arm 10 by the elastic member, and recesses formed in the lower surface of the base end portion of the liquid supply arm 10. The liquid supply arm 10 is held at the liquid supply position F, the first retracted position D or the second retracted position E when the ball engages with the corresponding one of the recesses. When a torque exceeding a predetermined value is applied to the liquid supply arm 10, the arm 10 can be released from the position where it was held by the detent mechanism.

[0024] The slide member 14 is supported for sliding on the slide mechanism 12. However, the slide member 14 is restrained from sliding off the slide mechanism 12 in a direction X by a detent mechanism similar to the detent mechanism 50.

[0025] The nozzle assembly has a nozzle holding member 40. A forward end portion of the nozzle holding member 40 projects downward from an opening 21 formed in a forward end portion of the lower wall of the cover 13. The nozzles 23 are held by the nozzle holding member 40 so that the distal end portions thereof project vertically downward from the lower surface 19 of the nozzle holding member 40. The proximal ends of the nozzles 23 are respectively connected to supply tubes 25 via connectors 24. If the distal ends of the nozzles 23 are flush with the lower surface 19, liquids such as a polishing liquid and dressing liquid discharged from the nozzles 23 have a tendency that little quantities thereof remain on the lower surface 19 of the nozzle holding member due to their surface tension, whereby a mixing of the remaining liquids or a contamination can be brought about. However, in this embodiment, since the distal end portions of the nozzles 23 are projected from the lower surface 19 of the nozzle holding member and are spaced apart from each other, such a mixing or contamination can be avoided.

[0026] While the four supply tubes 25 are extended out from the cover 13, they are inclined at a predetermined angle θ to a horizontal plane to prevent the liquids from remaining in the supply tubes 25.

[0027] A polishing liquid, a dressing liquid, a dispersant or cleaning liquid and chemical liquids such as an oxidizer liquid or the like may be supplied to the supply tubes 25, respectively. Specifically, the supply tubes 25 may be connected to different tanks T or sources of such liquids, respectively, as shown in Fig. 7. The number and construction of the nozzles 23 and the supply tubes 25 are determined as required.

[0028] The operation of the liquid supply arm 10 will be described hereinafter.

[0029] When the liquid supply arm 10 is located and held by the detent mechanism 15 at the liquid supply position F as shown in Fig. 5, the center of the arrangement of the four nozzles 23 coincides with the turning axis of the turntable 73. When polishing the semiconductor wafer by holding the semiconductor wafer on the lower surface of the wafer carrier 75 and pressing the same against the polishing surface of the polishing pad 74 of the turntable 73, the polishing liquid is discharged from a predetermined one of the nozzles 23 held on the forward portion of the liquid supply arm 10.

[0030] The polishing liquid thus discharged falls vertically on the central portion of the turntable 73, and is forced to spread uniformly over the entire surface of the turntable 73 by a centrifugal force.

[0031] When the dressing tool 79 is operated for a dressing operation, a dressing liquid is discharged through another nozzle 23 for the dressing liquid. The dressing liquid falls vertically on the central portion of the turntable 73 and is forc d to spread uniformly over the entire surface of the polishing pad 74.

[0032] While the nozzle in the conventional polishing machine as shown in Fig. 1 discharges a liquid obliquely onto the turntable, the nozzles 23 supported by the liquid supply arm discharge liquids vertically onto the central portion of the turntable 73 and, as a result, the liquids can be supplied accurately onto a desired region of the polishing surface of the turntable 73.

[0033] The liquids can be vertically supplied onto the turntable 73 by a different method without arranging the nozzles 23 to extend vertically as shown in Fig. 7. In the different method, a flow regulating valves V is provided in the lines connecting the nozzles and the tanks T storing the liquids to control the flow rates of the liquids supplied to the nozzles so that the liquids discharged from the nozzles will instantaneously fall vertically even if the tip end portions of the nozzles are extended obliquely.

[0034] When changing the polishing pad 74 attached to the upper surface of the turntable 73 to a new one, the liquid supply arm 10 is turned by hand to the first retracted position D shown in Fig. 5. The liquid supply arm 10 is then held stationary at the first retracted position D by the detent mechanism 15. Consequently, there is nothing immediately above the polishing pad 74 of the turntable 73, so that the change of the polishing pads 74 can easily be conducted.

[0035] During the polishing pad change operation, the nozzles 23 supported on the forward end portion of the liquid supply arm 10 located at the first retracted position D are positioned just above the notch 103 of the splash cover 101, whereby liquids which may remain inside and drop from the nozzles 23 after ceasing the supply of the liquids to the nozzles 23 fall through the notch 103 into the annular trough 111 and thus the surroundings of the turntable 73 is not contaminated by the dropping liquids.

[0036] The drainage system also makes it possible that a pure water source is additionally connected to the tubes 25 so that pure water can be flowed through the tubes and nozzles after the supply of the polishing liquid, the dressing liquid and so on to clean the tubes and nozzles without contaminating the surroundings of the turntable 73.

[0037] The liquid supply arm 10 is moved to the second retracted position E and held by the detent mechanism when it is necessary to carry out maintenance work of the polishing machine which cannot be done with the liquid supply arm 10 located at the liquid supply position F or the first retracted position D, said maintenance work which includes dismounting the nozzle assembly 40 from an arm body 11 of the liquid supply arm to measure supply or discharging rates of the liquids discharged from the nozzles 23, removing pieces of a s miconductor wafer broken on the turntable 73, removing the splash cov r 101 to remove the pieces

of broken semiconductor wafer from the annular trough 111, inspecting the entire turntable 73 and repairing the liquid supply system.

[0038] In this state, nothing overlies the turntable 73 and the splash cover 101 and hence the maintenance work can easily be conducted.

[0039] Since the second retracted position E is close to a side wall of the polishing unit 70, the maintenance of the liquid supply system can easily be performed from the outside of the polishing unit 70. A retracted position G shown in Fig. 5 may be used instead of the second retracted position E.

[0040] The discharging rate at which the liquid is discharged through each nozzle 23 must be measured to adjust the rate to an appropriate value. In this embodiment, the discharging rate is measured by either of the following two methods.

[0041] In a first measuring method, the liquid discharged from each nozzle 23 is directly measured by a graduated cylinder or the like. The measurement may be carried out by for example placing the liquid supply arm 10 at the first retracted position D or removing the nozzle unit 40 together with the slide member 14 from the liquid supply arm and placing it on a place convenient for the measurement. To remove the nozzle assembly from the arm 10, screws 16 (Figs. 6 and 7) are first removed and then the nozzle assembly with the slide member 14 is moved in the direction X to thereby be separated from the arm.

[0042] In a second measuring method, the cover 13 is pulled in the direction designated by an arrow Y to remove the cover 13 from the slide member 14, the supply tubes 25 are then disconnected from the connector 24, the free end portions of the supply tubes 25 are moved to a place convenient for the measurement and, thereafter, the flow rates of the liquids discharged from the free ends are measured.

[0043] The second measuring method does not measure quantities of the liquids discharged from the nozzles 23. Therefore, it is possible that a discharging rate measured by the second measuring method may include an error greater than an error which may be included in the measurement by the first measuring method. However, the second measuring method is more convenient and simpler than the first measuring method where slide member 14 and associated elements are removed from the arm body 11 of the liquid supply arm.

[0044] In this embodiment, the liquid supply arm 10 is turned on the pivot shaft 50 and the position of the liquid supply arm 10 can easily be detected by a position sensor combined with the pivot shaft 50. Therefore, it is possible to improve the polishing machine in terms of safety by providing an interlocking mechanism which controls the drive of the polishing machine so that, when it is detected that the liquid supply arm is not appropriately located at the liquid supply position F in a polishing operation, the driving of the polishing machine is stopped. For example, it is possible to avoid damaging the liquid supply arm 10 and the dressing unit 81 by a collision therebetween which may be brought about by a turn of the dressing unit 81 about its pivot shaft when the liquid supply arm 10 is at a position out of th liquid supply position F.

[0045] As shown in Fig. 3, a dog 131 is attached to the splash cover 101 at a predetermined position, and a sensor 133 is attached to the arm body 11 at a position which is close to and opposite the dog 131 when the splash cover 101 is set correctly in place (Figs. 1 and 3) so that it is easy to determine whether the splash cover is set correctly or not. The splash cover 101 is vertically movable and is lowered when performing the maintenance of the turntable 73. If the polishing operation is performed with the splash cover 101 lowered, the polishing liquid and such are scattered around. A drive motor for driving the turntable 73 is therefore adapted to be prevented from being activated when the splash cover 101 is lowered and thus the sensor 133 does not detect the dog 131.

[0046] Further, it is possible to lower the splash cover 101 to the predetermined regular position or to raise the arm body 11 by a predetermined distance when the splash cover 101 is raised excessively so that it becomes impossible for the sensor 133 to detect the dog 131. Although in this embodiment both of the arm body 11 and the splash cover 101 are made to be vertically movable, it is possible for the arm body 11 not to move vertically.

[0047] The polishing machine in this embodiment has three positions where the liquid supply arm 10 can be held stationary by the detent mechanism 15. However, this invention is not limited to such an arrangement. The polishing machine may have at least one liquid supply position and at least one retracted position.

[0048] If the liquid supply arm 10 is arranged to be turned by a piston-cylinder actuator provided between the fixed frame of the polishing machine and the liquid supply arm 10, any mechanism like the detent mechanism 15 for holding the liquid supply arm 10 stationary is not needed. When such a piston-cylinder actuator is employed, a position sensing switch may be associated with the piston-cylinder actuator to sense and control the position of the liquid supply arm 10. A rotary actuator may be employed instead of the piston-cylinder actuator. Further, if the liquid supply arm 10 is driven for turning by a stepping motor, the liquid supply arm 10 can accurately be stopped and held at desired positions without any detent mechanism.

[0049] In this embodiment, the liquid supply position F is such a position that makes the center of the arrangement of the four nozzles 23 in the forward end portion of the liquid supply arm 10 coincides with the turning axis of the turntable 73. However, the liquid supply position F is not limited to such a position. For example, when the periphery of the semiconductor wafer 300 is not moved to the center of the turntable 73 in the pol-

ishing operation, the center of the arrangement of the four nozzles 23 may, as shown in Fig. 5, be located at any position In a circular center area of the polishing pad having a radius H which is not used for polishing a semiconductor wafer 300. This is because the liquid supplied onto such a circular center area will be appropriately spread over the polishing pad and supplied to the semiconductor wafer 300 which is being polished.

[0050] A polishing machine in according with a second embodiment of the present invention is shown in Figs. 8 to 12.

[0051] In the second embodiment, a liquid supply arm 10' includes fixed nozzles 23' fixedly held on a forward end portion of a body 11' of the arm 10', and a movable nozzle 23" longitudinally movably supported on the arm body 11'. The fixed nozzles 23' are formed from a tip or free end portions of tubes 25' connected to liquid supply sources including a dressing liquid source (not shown). The free end portions of the tubes 25' are passed through vertical through holes formed In the forward end portion of the liquid supply arm 10' and secured to the liquid supply arm 10' by a fixing member 27. The movable nozzle 23" is formed from a tip or free end portion of a tube 25" connected to a polishing liquid source (not shown). The free end portion of the tube 25" is passed vertically through longitudinal slots 28 formed in the arm body 11' and is held at a desired position by a movable fixing device 30. More specifically, the arm body 11' is a tubular member having a circular cross section and the longitudinal slots 28 are diametrically opposite each other in the vertical direction. The movable fixing device 30 includes a sliding member 32 which has a substantially circular cross section and is longitudinally slidably fitted in the aim body 11', a tube holding member 36 positioned below a lower surface of the arm body 11', and a bolt 34 which passes through the longitudinal slots 28 in the vertical direction and is threadably engaged with the tube holding member 36. The free end portion of the tube 25" passing through the slots 28 is fastened to the tube holding member 36 by a fastening member 38.

[0052] The bolt 34 is passed through a vertical hole formed in the sliding member 32 and is threadably engaged with a threaded hole formed in the tube holding member 36. The tube holding member 36 can thus be lifted and lowered relative to the arm body 11' by turning the bolt 34 about its axis so that the sliding member 32 is fixedly engaged with and disengaged from the arm body.

[0053] In the embodiment shown in Fig. 8, the movable nozzle 23" is located at a radial position on the polishing surface of the turntable corresponding to the center of a wafer 300 which is being subjected to the polishing operation, while the fixed nozzles are positioned at the center of the polishing surface of the turntable. Although, in this embodiment, only the nozzle for discharging a polishing liquid is made to b movable, any other nozzles may be made to be movable as required. For example, it is preferable that th nozzles for discharging a dispersant liquid and the nozzle for discharging an oxidizer liquid are movable so that those nozzles can be located at the same position as the polishing liquid.

INDUSTRIAL APPLICABILITY

[0054] As is apparent from the foregoing description, according to the present invention, (1) since the liquid supply arm can be located outside the turntable as required, the maintenance work which includes changing the polishing pads can easily be carried out without being hindered by the liquid supply arm thereby shortening the time for the maintenance operation and (2) since the liquids discharged from the nozzles are directed vertically, the liquids can be appropriately supplied onto a desired position on the turntable.

Claims

1. A polishing machine comprising:

   a turntable having a polishing surface; and
   a liquid supply system for supplying a liquid such a polishing liquid onto said polishing surface;
   wherein said liquid supply system comprises a movable arm, and a nozzle supported on said movable arm to discharge the liquid onto said polishing surface;
   said movable arm is capable of being moved between a liquid supply position whereby said nozzle is positioned substantially vertically above a portion of said polishing surface onto which the liquid is to be discharged, and at least one retracted position whereby said nozzle is positioned radially outside said periphery of said polishing surface; and
   said polishing machine further comprises an arm holding device for holding said movable arm at said liquid supply position and said retracted position, respectively.

2. A polishing machine according to claim 1, wherein said liquid supply system is provided with a flow regulating device that regulates a flow rate of the liquid so that the liquid discharged from the liquid supply nozzle flows down substantially vertically onto said portion of said polishing surface.

3. A polishing machine according to claim 2, wherein said movable arm includes a pivot shaft disposed radially outside the periphery of said turntable and said movable arm can pivot about said pivot shaft.

4. A polishing machine according to claim 3, wherein said movable arm is vertically movable.

5. A polishing machine according to claim 3, wherein the liquid supply system comprises a plurality of nozzl s respectively connected to different kinds of liquid sources.

6. A polishing machine according to claim 1 further comprising an annular splash cover which is movable between an upper position to prevent the liquid supplied on said polishing surface from scattering outside said periphery of said polishing surface and a lower position below a level of the polishing surface.

7. A polishing machine according to claim 1, wherein said nozzles is capable of being moved on said movable arm so that the position of said nozzle on said movable arm positioned at said liquid supply position can be adjusted relative to said polishing surface in a radial direction of said polishing surface.

8. A polishing machine according to claim 6, further comprising a liquid drainage member disposed under said annular splash cover to receive the liquid which drops from said splash cover after being scattered outside said periphery of said polishing surface and stopped by said splash cover.

9. A polishing machine according to claim 8, wherein first and second retracted positions are prepared as said retracted position, said first retracted position being close to said periphery of said turntable, said second retracted position being radially outwardly apart from said periphery of said turntable, said liquid drainage member being adapted to receive the liquid from said nozzle on said movable arm positioned at said first retracted position.

10. A polishing machine according to claim 1, wherein said holding device is a detent mechanism.

11. A polishing device according to claim 6, wherein said movable arm is provided with a position sensor for sensing the vertical position of said movable arm relative to said annular splash cover.

12. A polishing machine according to claim 1, wherein said nozzle has a distal end through which the liquid is discharged and a proximal end, said distal end is extended vertically downward, said liquid supply system includes a liquid supply tube detachably connected to said proximal end of said nozzle, and said liquid supply tube slants upward from the proximal end of said nozzle.

13. A polishing machine according to claim 5, wherein said liquid supply system further comprises a nozzle mount member for removably mounting said nozzles on said movable arm, said nozzle mount member has a lower surface, and said nozzles are extended through said nozzle mount member in such a manner that distal ends of said nozzles project downward from said lower surface of said nozzle mount member, said distal ends being separated from each other.

14. A polishing machine comprising:

a turntable having a polishing surface; and
a liquid supply system for supplying liquids such as a polishing liquid onto said polishing surface;
wherein the liquid supply system comprises a movable arm, and a nozzle supported on said movable arm to discharge the liquid onto said polishing surface;
the movable arm is capable of being moved to a liquid supply position above said polishing surface to supply the liquid onto said polishing surface, a liquid emptying position radially outside the periphery of said polishing surface for emptying the liquid out of said nozzle, and a retracted position radially outside said liquid emptying position; and
said polishing machine further comprises an arm holding device for holding said movable arm at said liquid supply position, said liquid emptying position and said retracted position, respectively.

15. A polishing machine according to claim 14 further comprising an annular splash cover which is movable between an upper position to prevent the liquid supplied on said polishing surface from scattering outside said periphery of said polishing surface and a lower position below a level of the polishing surface.

16. A polishing machine according to claim 15 further comprising a liquid drainage member disposed under said annular splash cover to receive the liquid which drops from said splash cover after being scattered outside said periphery of said polishing surface and stopped by said splash cover, said liquid drainage member being adapted to receive the liquid emptied out of said nozzle on said movable arm positioned on said liquid emptying position.

17. A polishing machine comprising:

a turntable having a polishing surface; and
a liquid supply system for supplying liquids such as a polishing liquid to the polishing surface;
wherein the liquid supply system comprises a movable arm, and a plurality of nozzles sup-

ported on the movable arm to discharge liquids onto said polishing surface;

said movable arm is capable of b ing moved between a liquid supply position where said nozzles are positioned above said polishing surface for supplying the liquids onto said polishing surface, and at least one retracted position radially outside the periphery of said polishing surface; and

at least two of said plurality of nozzles are connected to liquid sources of different kinds of liquids, respectively.

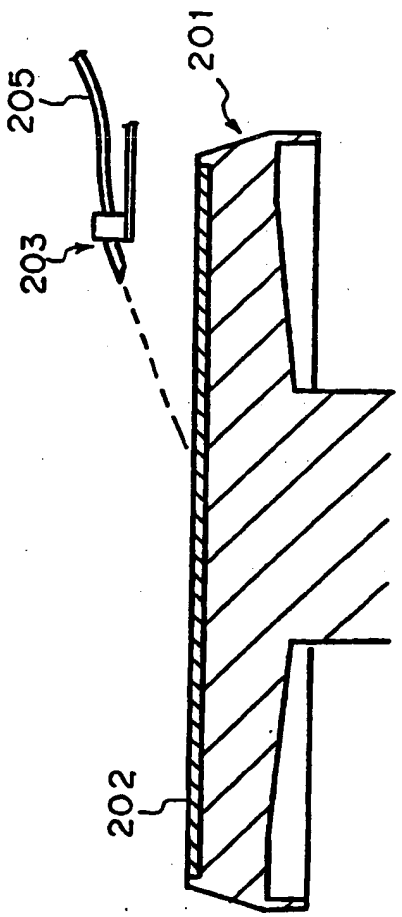


Fig. 1

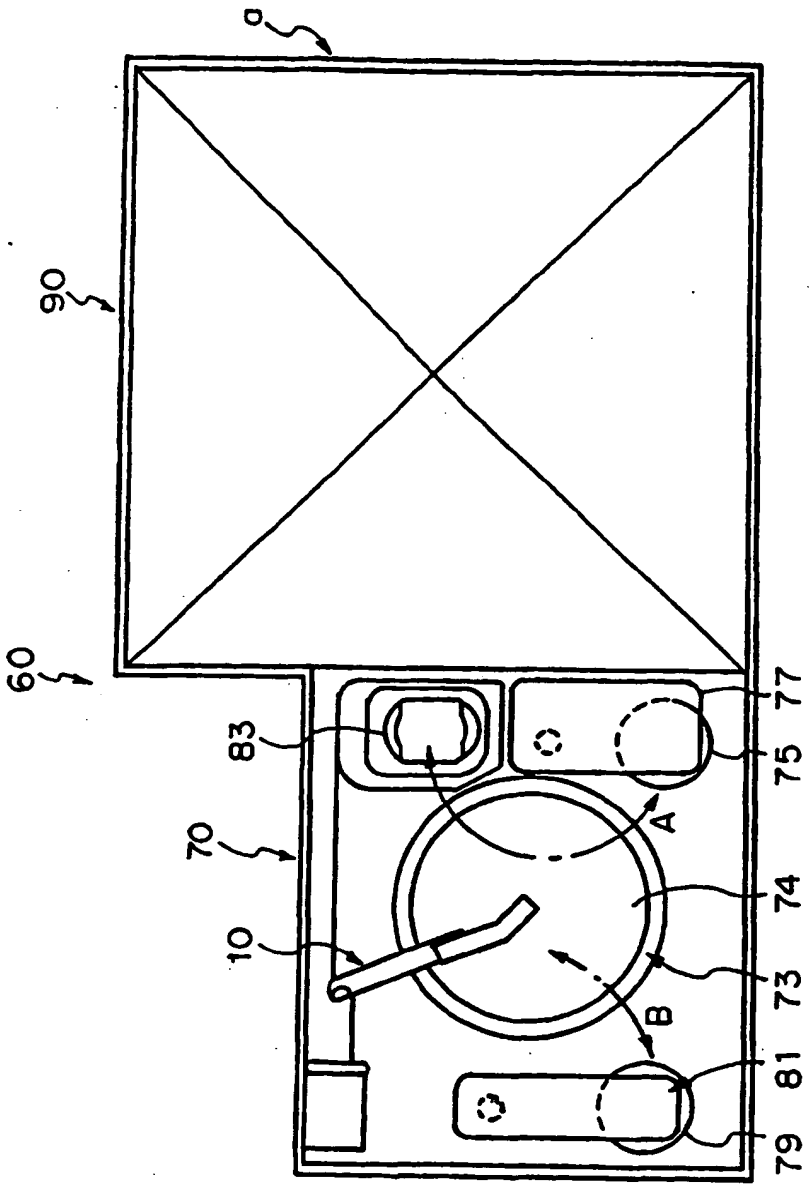


Fig. 2

Fig. 3

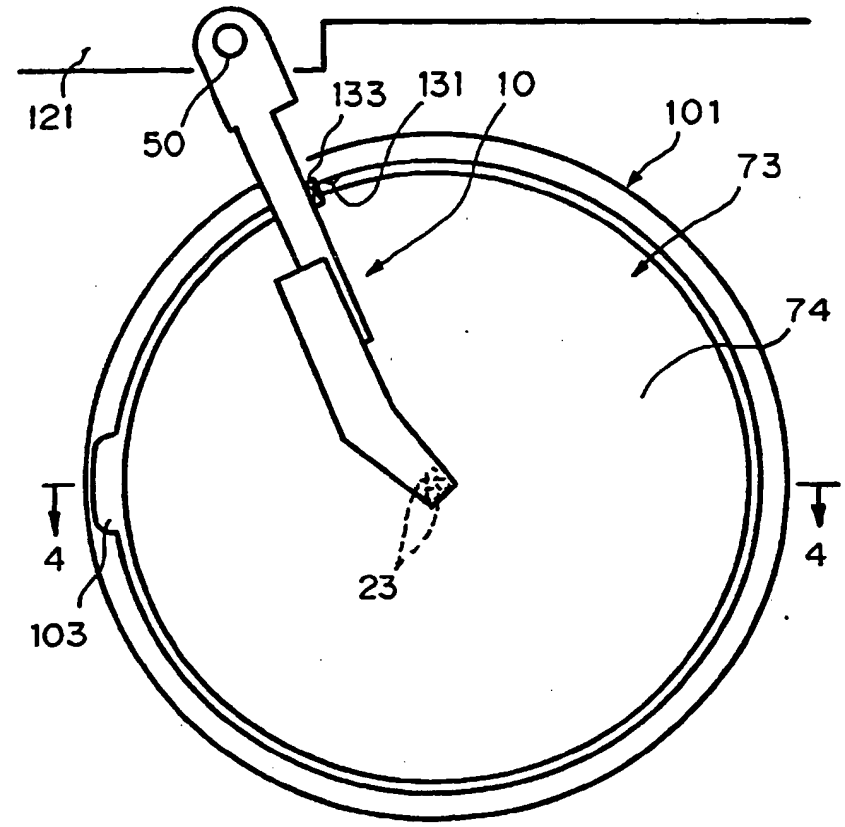


Fig. 4

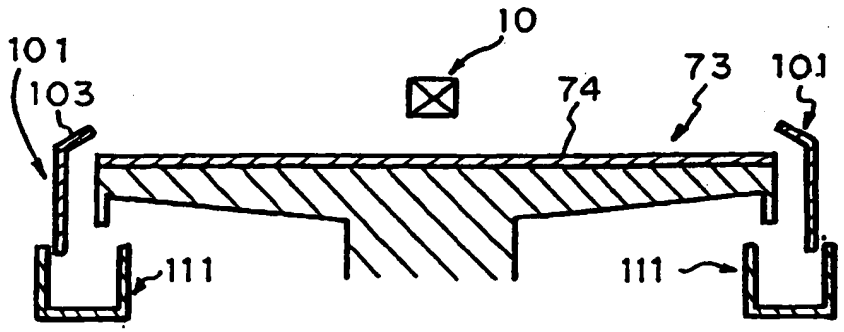


Fig. 5

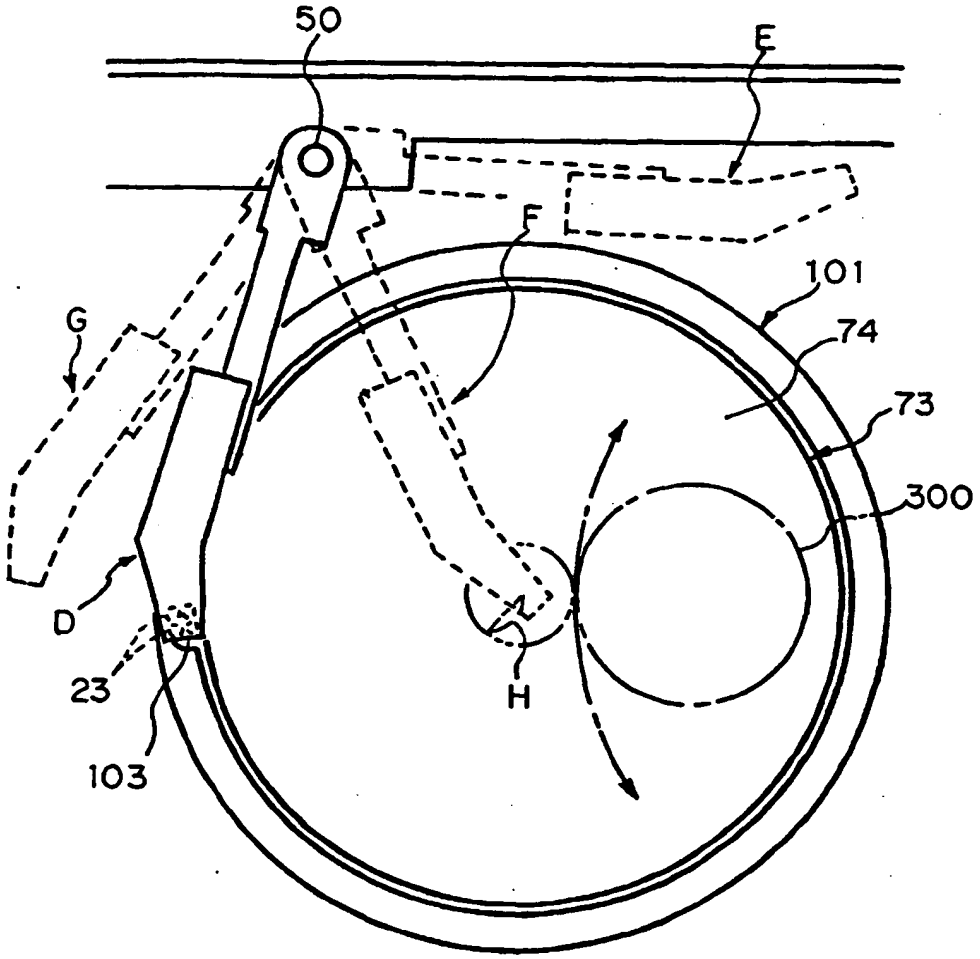


Fig. 6

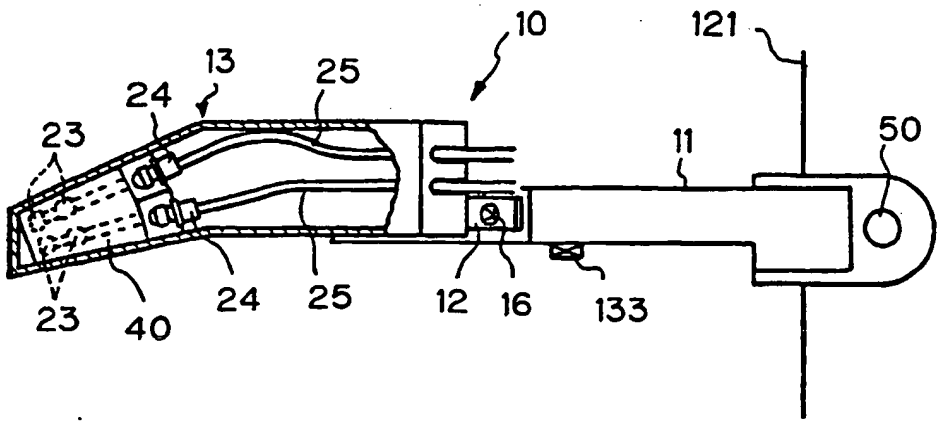
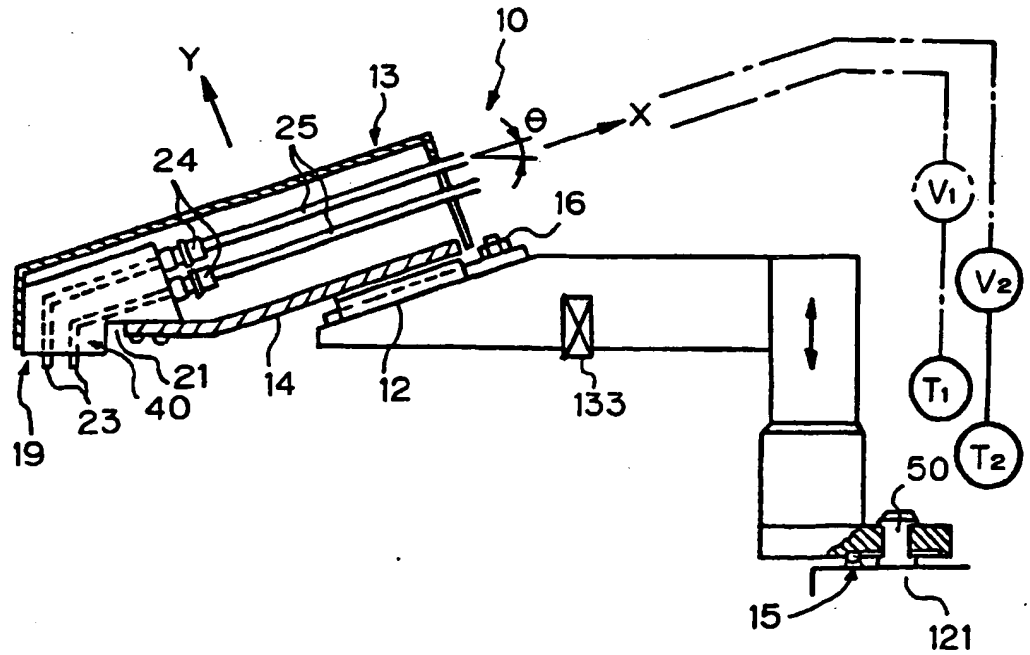


Fig. 7



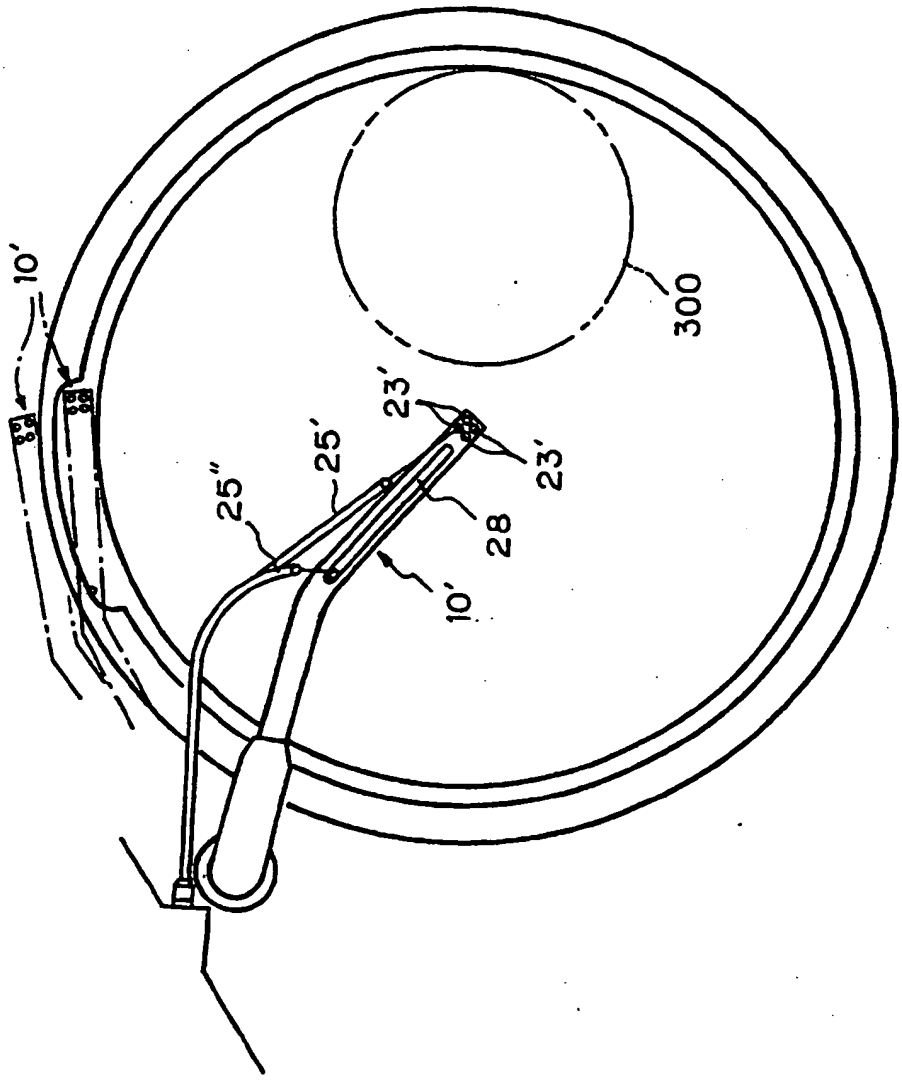


Fig. 8

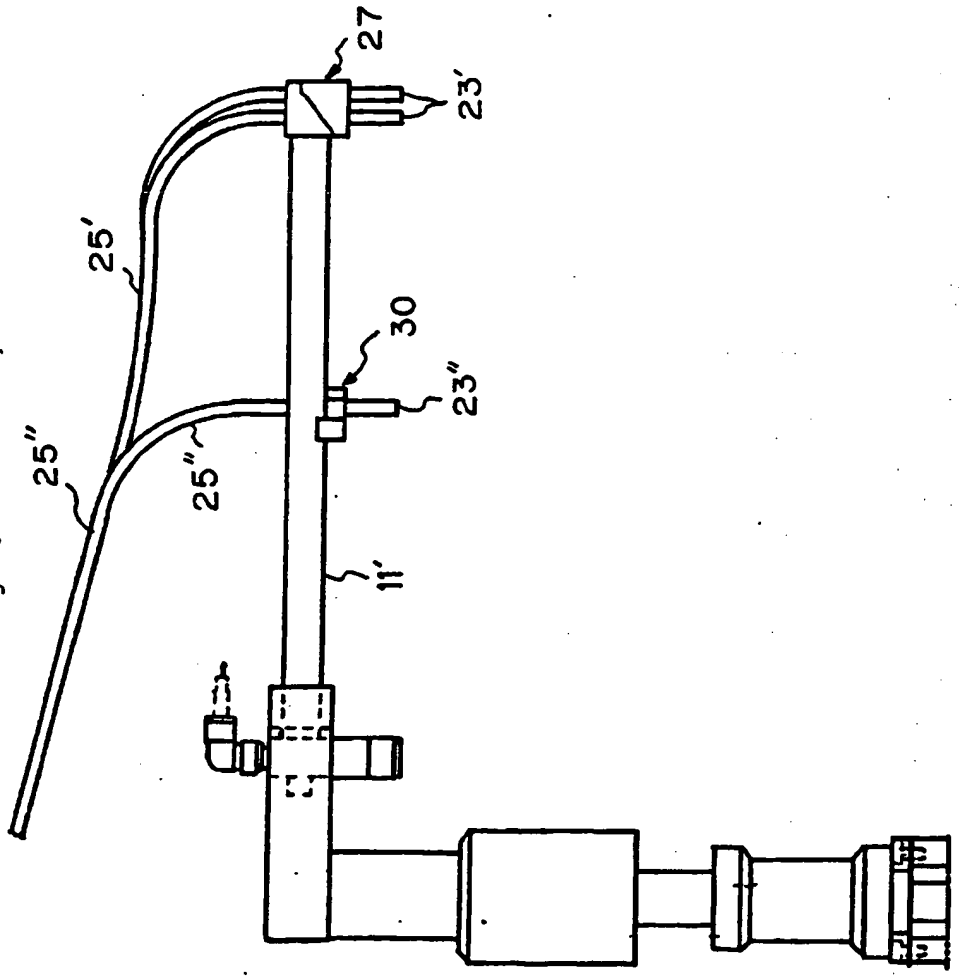


Fig. 9

Fig. 10

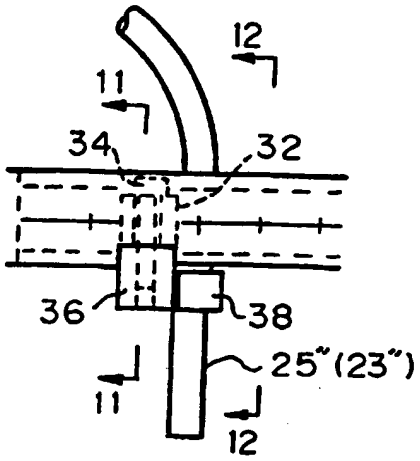


Fig. 11

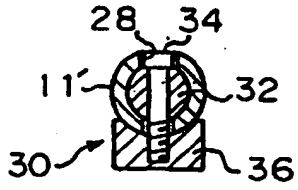
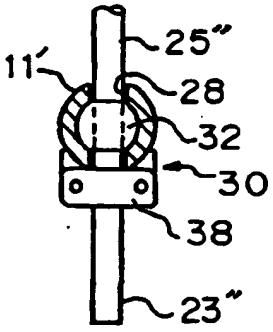


Fig. 12



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/05992

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[6] B24B37/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[6] B24B37/00, 37/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-1999
Kokai Jitsuyo Shinan Koho 1971-1996 Jitsuyo Shinan Toroku Koho 1996-1999

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP, 9-174420, A (Applied Materials,Inc.), 8 July, 1997 (08. 07. 97), Par. Nos. [0145], [0148], [0149], [0151] ; Figs. 22 to 25 & EP, 774323, A2 & US, 5738574, A & KR, 97023803, A	1-3, 5, 10, 17 2, 4, 6-9, 11-16
X Y	JP, 7-223142, A (Ebara Corp.), 22 August, 1995 (22. 08. 95), Par. No. [0032] ; Fig. 7 (Family: none)	1, 3, 4, 10 2, 5-9, 11-17
X Y	JP, 8-257899, A (Toshiba Machine Co., Ltd.), 8 October, 1996 (08. 10. 96), Par. Nos. [0021], [0026], [0031] ; Fig. 2 & US, 5660581, A	1, 3, 6, 8, 10 2, 4, 5, 7, 9, 11-17
Y	JP, 9-57610, A (Ebara Corp.), 4 March, 1997 (04. 03. 97), Par. Nos. [0011] to [0013] ; Fig. 1 (Family: none)	1-17

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 March, 1999 (30. 03. 99)	13 April, 1999 (13. 04. 99)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/05992

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP, 61-188071, A (NEC Corp.), 21 August, 1986 (21. 08. 86), Claims ; Figs. 1, 2 (Family: none)	2-5 1, 6-17
Y A	JP, 7-201786, A (Sumitomo Electric Industries,Ltd.), 4 August, 1995 (04. 08. 95), Par. No. [0004] ; Fig. 3 (Family: none)	5, 13, 16 1-4, 6-12, 14, 15, 17
Y	Microfilm of Japanese Utility Model Application No. 63-34580 (Laid-open No. 1-138659) (Toshiba Machine Co., Ltd.), 21 September, 1989 (21. 09. 89), Page 3, lines 12 to 19 ; Fig. 2 (Family: none)	8, 9, 11, 15, 16
Y	Microfilm of Japanese Utility Model Application No. 63-61936 (Laid-open No. 1-164060) (Nippon Telegraph & Telephone Corp.), 15 November, 1989 (15. 11. 89), Figs. 1 to 4	8, 9, 16

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